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SIXBEY FRIEDMAN LEEDOM & FERGUSON
2010 CORPORATE RIDGE
SUITE 600
MCLEAN VA 22102

EXAMINER	
HAWRANEK,S	
ART UNIT	**PAPER NUMBER**
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Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Serial Number: 08/462,742

Art Unit: 1104

Part III DETAILED ACTION

Specification

1. The lengthy specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

Claim Rejections - 35 USC § 112

2. Claims 3 and 4 and dependent claims 5-12 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. "[S]ubstantial" should be -substantially--. The term "and the other region no metal...film" is confusing and lacks antecedent basis. A possible correction would be --and in another region where no metal element was selectively introduced the silicon film remains amorphous--.

In claim 4, polycrystalline and not amorphous silicon is grown during crystallization.

In claim 4 it is unclear what a "carrier" is. For examination purposes, it was assumed that the carrier was the moving nickel silicide recrystallization front (i.e. the moving a-Si/polysi boundary).

The last paragraph of claim 4 is run on and should be rewritten.

3. Claims 14-25 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

The terms "silicon film having an amorphous" and "another region has the silicon film having the amorphous" are confusing. A possible correction would be --an amorphous silicon film-- and --another region where the silicon remains amorphous--.

Also no positive catalyst introduction step is claimed, i.e. "preparing a metal...to introduce into an introducing region" should be --preparing a metal...and introducing said metal into an introducing region--.

The term "wherein the silicon film is crystal-grown" is vague because it implies a Czochralski single crystal growth method. A possible correction would be --wherein grains in the silicon film grow from the introducing region--.

In claims 20 and 21 the crystal growth region and another region, and not TFTs, are not driving or picture circuit portions, respectively. A possible correction would be --wherein a least one TFT is provided in both the crystal growth region and the another (second) region, and wherein said crystal growth

region comprises the peripheral driving circuit portion of an LCD and the another (second) region comprises the picture (pixel) circuit portion of an LCD--.

In claims 21-22 it is unclear what a "carrier" is. For examination purposes, it was assumed that the carrier was the moving nickel silicide recrystallization front (i.e. the moving a-Si/polysi boundary).

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. § 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless --
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

5. Claims 3-8, 11-12, 14, 16, 18-25 are rejected under 35 U.S.C. § 102(b) as being anticipated by Liu et al. (US '826). Liu teaches to form hydrogenated amorphous silicon (a-Si) channel pixel (picture) TFTs and polysilicon channel driver (peripheral) TFTs (Col. 3, Lines 6-17) on Corning 7059 substrates by forming a thin layer of catalyst metal, such as Ni, in contact with peripheral LCD regions and subsequently growing 30-40 micron polysilicon regions at a temperature of 550 °C while other regions where catalyst was not introduced remained amorphous (Col. 6, Lines 1-21). Thus, the Ni concentration, [Ni], is higher

in the peripheral region (i.e., sufficient [Ni] to induce low temperature recrystallization) than in the pixel region (insufficient [Ni] to induce low temperature recrystallization). It is held, absent evidence to the contrary that the a NiSi front (carrier) moving parallel to the substrate was the leading edge of the recrystallization, see In Re Best 195 USPQ 428 and In Re Fitzgerald et al., 205 USPQ 594.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. § 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.
>
> Subject matter developed by another person, which qualifies as prior art only under subsection (f) or (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person.

7. Claims 3-8,11-12,14-25 are rejected under 35 U.S.C. § 103 as being unpatentable over Liu et al. (US '826) in view of either Okabayshi et al. (JP '326) or Hayzelden et al. (Appl. Phys. Lett.), together or further in view of Dvurechenskii et al.

(Phys. Stat. Sol.) used as teaching references. Liu teaches to form hydrogenated amorphous silicon (a-Si) channel pixel (picture) TFTs and polysilicon channel driver (peripheral) TFTs (Col. 3, Lines 6-17) on Corning 7059 substrates by forming a thin layer of catalyst metal, such as Ni, in contact with peripheral LCD regions and subsequently growing 30-40 micron polysilicon regions at a temperature of 550 °C while other regions where catalyst was not introduced remained amorphous (Col. 6, Lines 1-21). Thus, the Ni concentration, [Ni], is higher in the peripheral region (i.e., sufficient [Ni] to induce low temperature recrystallization) than in the pixel region (insufficient [Ni] to induce low temperature recrystallization). It is held, absent evidence to the contrary that because liu stresses depositing the discontinuous metal catalyst layer as thinly as possible to minimize [Ni] in the device the [Ni] at the edge of the diffusion (grain growth) region is around $1x10^{19}/cm^{-3}$. Liu also teaches that annealing in an oxygen ambient decreases the crystallization temperature (Col. 5, Line 7). Liu does not specify the direction of the crystallization front.

Okabayashi teaches that in a thin Ni doped a-Si, a $NiSi_2$ crystallization front moves parallel to the substrate, leaving behind polysilicon (Abstract).

Hayzelden teaches that in thin Ni doped a-Si, a $NiSi_2$ crystallization front moves parallel to the substrate, leaving

behind polysilicon with needle like grains and a preferred grain orientation. Crystal growth was parallel to <111> directions (Page 226). Silicide front also moves in the <111> directions (i.e. when growth occurs on the (111) face (plane) of a $NiSi_2$ precipitate (Page 227), the growth direction must be perpendicular to said plane, and thus said movement direction is also the <111> direction).

Dvurechenskii teaches that a low does of Ni, such as 10^{18} cm^{-3} is sufficient to improve a-Si conductivity at 500°C (i.e. probable partial recrystallization) (Fig. 4).

Therefore, it would have been obvious to one of ordinary skill in the art that the grain growth and the silicide front of Liu move parallel to the substrate as taught by Okabayashi or Hayzelden because they are all examples of nickel silicide mediated recrystallization, which may proceed at low [Ni} as taught by Dvurechenskii.

8. Claims 9-10 are rejected under 35 U.S.C. § 103 as being unpatentable over Liu in view of Okabayashi or Hayzelden together or further in view of Dvurechenskii as applied to claims 3-8, 11-12, 14-25 above, and further in view of either Yonehara (US '093) or Wada et al. (US '191) or Shibata (US '224) or Shibata (JP '224). Liu et al. do not teach irradiating the polysilicon after thermal recrystallization.

Yonehara, Wada, Shibata and Shibata teach that flash lamp and laser irradiation of recrystallized polysilicon improves its properties, such as mobility.

Therefore, it would have been obvious to one of ordinary skill in the art to irradiate the TFTs of Liu after recrystallization in order to improve their mobility.

Conclusion

9. Examiner Query: Applicant claims that Ni concentration of $1x10^{15}$ - $1x10^{19}$ cm^{-3} is sufficient to initiate catalyst mediated (low temperature) recrystallization, and that higher Ni concentration leads to NiSi ($NiSi_2$?) cluster precipitation (Page 7). However, according to most scientific literature (such as Hayzelden, Kuznetsov or Okabayashi), catalyst mediated recrystallization occurs when $NiSi_2$ precipitates move through the a-Si, and leave a region of polysilicon behind. Thus, if formation of $NiSi_2$ is discouraged in the current application, it is unclear by which mechanism the low temperature crystallization proceeds. Furthermore, Kuznetsov, et al. (NI&MPR) teach that for Ni concentrations below 10^{19} cm^{-3} no catalyst mediated recrystallization occurs (Page 261, Col. 2).

10. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

a. Scovell et. al. (GB '844) teach a transient anneal of polysilicon.

b. Kumoni (US '661) teaches that crystallization from ion implanted nucleating cites takes place parallel to the substrate.

c. Mori et al. (US '820) teach that patterned metals aid in a-Si crystallization.

d. Tajima (JP '419) teaches that Co actually hinders a-Si recrystallization!

e. Schoenfeld et al. (Thin Solid Films, J. Phys. Chem. Solids) teach that polysilicon grain size is a function of [Ni].

f. Young (US '383,Col. 3), Magarino et al. (US '321, claim 6) and Aoyama et al. (JP '320) teach a-Si pixel and polysi driver TFTs.

g. Zhang et al. (US '772) teaches catalyst mediated crystallization in the first embodiment, and a-Si pixel and polysi driver TFTs manufactured by using a cover film only on the driver TFT during an anneal in a controlled atmosphere, in a second embodiment.

h. Doyle et al. (US '530), Cline et al. (US '762) and Sandera (US '049) teach spin coating nickel.

11. In order to ensure full consideration of any amendments, affidavits or declarations, or other documents as evidence of patentability, such documents **must** be submitted in response to this Office action. Submissions after the next Office action, which is intended to be a final action, will be governed by the requirements of 37 C.F.R. § 1.116, which will be strictly enforced.

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to **Leon Radomsky** whose telephone number is (703) 305-3445.

Any inquiry of a general nature or relating to the status of this application should be directed to the Group receptionist whose telephone number is (703) 308-0661. Group 1100 fax number is (703) 305-3600.

LR

10/5/95

BRIAN E. HEARN
SUPERVISORY PRIMARY EXAMINER
GROUP 1100